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Summary of Studies Related to Hydraulic Fracturing Conducted by USGS Water Science Centers

Of recent importance is the issue that involves impacts of oil and gas production and hydraulic fracturing on groundwater and surface-water quantity and quality and ecosystems. "On-the-ground" projects are currently proposed or ongoing in more than 15 States, designed with cooperators and partners, and in large part supported by jointly funded projects with localities, States, and Tribes through the Cooperative Water Program (as well as projects with other Federal agencies). In general the projects help to establish baseline water quantity and quality measurements and assessments as natural gas exploration and production accelerates among different geologic and environmental settings across the U.S. Such understanding is critical to protect sources of water used for drinking and to sustain ecosystem health in our Nation's streams, lakes, and reservoirs.

National analysis and synthesis by the USGS John Wesley Powell Center –

- Maps related to oil and gas production and hydraulic fracturing are included in the USGS Fact Sheet "*Water Quality Studied in Areas of Unconventional Oil and Gas Development, Including Areas Where Hydraulic Fracturing Techniques are Used in the U.S*." Specifically, maps show oil- and gas-related wells in the U.S.; major areas of unconventional oil and gas development in the U.S.; number of groundwater-quality samples in areas of unconventional oil and gas development; and number of surface-water quality samples in areas of unconventional oil and gas development.

  This Fact Sheet was developed by the USGS John Wesley Powell Center for Analysis and Synthesis, which is hosting a work group to (1) better understand hydraulic fracturing in the U.S., (2) assess quality of surface water and groundwater in areas of unconventional oil and gas production, (3) evaluate potential changes in water quality over time, (4) determine baseline concentrations of major ions in waters in areas of unconventional oil and gas production, (5) identify spatial and temporal gaps, and (6) identify future research needed to better understand effects of oil and gas production and hydraulic fracturing on surface-water and groundwater quality. (**Contact**: gs_powell_center_hydrofrac@usgs.gov).

Pennsylvania –

- USGS is establishing baseline data before natural gas exploration and production activities in the Marcellus Shale accelerate within and near watersheds in Blair County, Pennsylvania. These watersheds supply the Altoona Water Authority (AWA) water-supply system serving water to about 70,000 people (project initiated Spring 2012). Activities associated with exploration and development of the Marcellus Shale natural gas reserve have the potential to impact source waters for the AWA and other streams in Blair County. This project will establish baseline information on channel morphology, stream chemistry, and benthic invertebrate and fish assemblages. Cooperating and partnering agencies are the Altoona Water Authority, Blair County Conservation District, Southern Alleghenies Conservancy, and the John Kennedy Chapter of Trout Unlimited. A peer-reviewed scientific report is planned that includes results from the 2011-2013 sampling. Data will be managed in and disseminated through the USGS National Water Information System. (NWIS) and be available to the public. In addition, a public web site is proposed that will be dedicated to displaying the status of the project and data collected by the project. (**Contact:** Robin Brightbill, rabright@usgs.gov, (717) 730-6978)

- USGS is establishing a baseline of surface- and groundwater-quality data as Marcellus Shale natural gas exploration and production activities accelerate in the Lycoming Creek watershed, north-central Pennsylvania (project initiated in 2011). The study is limited to a one-time synoptic "snapshot" of a broad suite of water-quality parameters during base-flow conditions. Samples will be collected from 30 sites on tributaries or the main stem of Lycoming Creek and from 9 of the WMWA production wells. The baseline groundwater-quality information provided by this study will be important for determining where future contamination occurs and the severity of that contamination. The cooperating agency is the Williamsport Municipal Water Authority. Data will be managed in and disseminated through the USGS National Water Information System. (NWIS) and be available to the public. (**Contact:** Robin Brightbill, rabright@usgs.gov, (717) 730-6978)

- USGS continues work with the USEPA at a natural gas well in northern Washington County, Pennsylvania to assess potential impacts of hydraulic fracturing on drinking-water resources (to be completed in 2014). Monitoring follows the water lifecycle at a natural gas well, including pre-gas-well drilling, gas-well drilling, hydraulic fracturing, gas-well production, and final disposition of fluids. Site geology, hydrogeology, groundwater flow, and groundwater quality are being characterized. In addition, the potential effect of Marcellus shale flowback/produced waters discharged from a waste water treatment plant to receiving surface waters used as a drinking-water source will be determined. A peer-reviewed, joint report is planned with the Pennsylvania Geological Survey. Data will be managed in and disseminated through the USGS National Water Information System. (NWIS) and be available to the public. (**Contact**: John Fulton, jwfulton@usgs.gov, (412) 490-3806)

- ***PROPOSED*** - USGS has proposed a one-year project for basic water-quality data collection in freshwater shallow aquifers overlying the Marcellus Shale in southern Sullivan County, Pennsylvania (project initiated Spring 2012). The cooperating agency is DCNR-Bureau of Topographic and Geologic Survey. A USGS data report is planned; results also will be included in a county report published by the State. Data will be managed in and disseminated through the USGS National Water Information System. (NWIS) and be available to the public. (**Contact**: Ron Sloto, rasloto@usgs.gov, (610) 321-2434, ext. 212)

New York –

(Selected projects are described on the New York WSC website. A webpage specifically dedicated to monitoring and studies related to Marcellus or unconventional shale is under development. (Contact: Denise Schwartz, dramelot@usgs.gov, (607) 266-0217, ext. 3029).

- Relative new 2012 funded projects – (**Contact:** Paul Heisig, pmheisig@usgs.gov, (518) 285-5648)
    - Sampling at approximately 60 wells in central Southern Tier counties for field parameters, flow-through headspace methane measurement, and methane (dissolved gases) in water concentration sample collection and analysis. Cooperating agency is NYSERDA (Governor's Office. A USGS fact sheet has been approved by all parties and project webpage is online. Field work to be done in May/June 2012 timeframe. http://ny.cf.er.usgs.gov/nyprojectsearch/projects/LK00-Meth-00.html
    - Synoptic specific conductance measurements on streams within the Southern Tier. Survey is anticipated during Summer 2012, however, dates must allow for rainfall events/recession periods. Cooperating agency is NY Department of Environmental Conservation. (**Contact**: tstevens@usgs.gov, Tia Stevens, (518) 285-5694)
    - Deployment of 3 real-time specific conductance probes in existing gaging stations (larger streams) in the Susquehanna River (2 locations) and Delaware River (1 location) Basins scheduled Spring

2012. Cooperating agency is NY Department of Environmental Conservation. (**Contact:** Paul Heisig, pmheisig@usgs.gov, (518) 285-5648)

A USGS Fact Sheet is anticipated (FY2012) on specific conductance (historic) in central and western New York streams. The information is relevant for comparison to the real-time measurements at the Susquehanna and Delaware River Basin sites. (**Contact**: Bill Kappel, wkappel@usgs.gov, (607) 266-0217, ext. 3013)

- The ongoing groundwater–quality monitoring project between the USGS and New York State Department of Environmental Conservation (NYSDEC) Division of Water supports analyses of methane and other gas constituents across the State on a rotating basis which will help characterize and track conditions associated with hydraulic fracturing. Overall, the project helps to support the NYSDEC's responsibilities under Section 305(b) of the Clean Water Act Amendments of 1977. The resulting data set will be used to establish a comprehensive groundwater quality baseline for New York State, characterizing naturally occurring, or background, conditions, and to identify long-term trends. (http://ny.water.usgs.gov/projects/305b/)

  A USGS Fact Sheet (FY2012) is anticipated from the 305(b) study that highlights "*Methane in New York*." (**Contact**: Bill Kappel, wkappel@usgs.gov, (607) 266-0217, ext. 3013)

- Several detailed aquifer mapping activities have been completed in the Marcellus shale drilling area. http://ny.water.usgs.gov/projects/bgag/aquifer.maps/index.html

- A USGS report is anticipated FY2012 that summarizes National Park Service groundwater sampling during Summer 2011 in relation to shale gas development in/near these Parks. (**Contact**: Dave Eckhardt, daeckhar@usgs.gov, (607) 266-0217, ext. 3018)

- Data collection for specific conductance has been added at selected gaged sites by the USGS Ithaca Office to provide information on background (or "pre-drilling") conditions. (**Contact**; Brett Hayhurst, bhayhurs@usgs.gov, (607) 266-0217, ext. 3003)

- Upcoming borehole geophysics work (**Contact**: John Williams, jhwillia@usgs.gov, (518) 285-5670):
  - Geophysical logging of a proposed gas well in Chenango County (Summer 2012).
  - Geophysical logging and water-quality sampling (with the Pennsylvania Water Science Center) at two 1,500 foot coreholes in Tioga and Bradford Counties, Pennsylvania (Summer 2012). Shell Oil Company has expressed interest in working with the USGS to expand this coring/logging/sampling program. Anadarko Petroleum Corporation expressed interest in sonic logging to help calibrate seismic surveys above the Marcellus.
  - Drilling and geophysical logging of monitoring wells are anticipated at the USEPA prospective hydraulic fracturing sites in western PA; no specifics at this time (May 2012).

- ***PROPOSED*** - Under development is a countywide database system for water quality in relation to future gas development in Oswega County. (**Contact**; Ward Freeman, wfreeman@usgs.gov, (518) 285-5665)

West Virginia –

- USGS is cooperating with the West Virginia Department of Environmental Protection to improve real-time management of withdrawals, principally for hydraulic fracturing, from small, ungaged streams throughout West Virginia. The distribution of streamgages and the spatial and temporal distribution of precipitation are being analyzed to determine representativeness of the streamgaging network. Areas will be ranked by their

need for new streamgages, considering seasonal differences in flow distribution and the sizes of streams where index gages are located. The project will be completed using existing data. A USGS Scientific Investigations Report is to be published by April 2013. (**Contact:** Terry Messinger, tmessing@usgs.gov, (304) 347-5130 x270.)

- USGS is cooperating with the West Virginia Department of Environmental Protection to provide estimates of base flow as part of water-withdrawal guidelines for hydraulic fracturing developed by the State. Base flows are being compared with published streamflow statistics to assess climate variability and to determine if available surrogate statistics and procedures are adequate for estimating annual and seasonal base flows of ungaged, unregulated streams in West Virginia. A USGS Scientific Investigations Report has been drafted, reviewed by colleagues, and is being prepared for submittal for Director's approval. (**Contact:** Jeffrey B. Wiley, jbwiley@usgs.gov, (304) 347-5130 x234.)

- USGS is cooperating with the West Virginia Department of Environmental Protection to document ambient groundwater quality in parts of north-central West Virginia that lie within the Marcellus Shale 50-ft isopach and is drained by the Monongahela River. The water-quality properties and constituents to be documented include those that are naturally occurring in the Marcellus Shale formation and are likely to be elevated in shallow groundwater through contact with return flows from hydraulic fracturing activities. Another objective will be to document existing contamination from other human activities that might introduce similar contaminants. Because additives to hydraulic fracturing fluids are variable and decrease in flow-back water over a relatively short time, water-quality analyses for this study will focus on documenting the major ions, trace elements, gases, radionuclides, and isotopes that can be used to represent potable water derived from shallow aquifers, water derived from contact with the Marcellus Shale (flow-back water from hydraulic fracturing or formation water), and water with contamination from other oil and gas fields, sewage effluent, and coal-mine drainage. A USGS Scientific Investigations Report will be published by January 2015. (**Contact:** Jeremy S. White, jswhite@usgs.gov, (304) 347-5130 x246 or Douglas B. Chambers, dbchambe@usgs.gov, (304) 347-5130 x231.)

- USGS is cooperating with the West Virginia Department of Environmental Protection (WVDEP) to install new stream gages on streams where gas development companies are withdrawing water for use in hydraulic fracturing for the Marcellus Shale gas play. The WVDEP is working with gas development companies to fund the installation, operation, and maintenance of USGS streamgages, with the agreement that gages are funded a minimum of five years. (**Contact:** Jeffrey B. Wiley, jbwiley@usgs.gov, (304) 347-5130 x234.)

Indiana –

- USGS is conducting a one-year investigation of groundwater quality in the vicinity of enhanced crude oil and natural gas production in southwestern Indiana (initiated Spring 2012). This project provides technical support to the Agency for Toxic Substances and Disease Registry (ATSDR) of the Centers for Disease Control as requested by the Indiana Department of Environmental Management in January 2011 because of complaints of petroleum and oilfield brine constituents in private wells. The one-year study is assessing hydrogeology, geochemistry, and groundwater quality and analysis of water from private wells near Mt. Vernon in Posey County, Indiana. Data will be managed in and disseminated through the USGS National Water Information System (NWIS). **(Contact**: Martin Risch, mrrisch@usgs.gov, (317) 600-2763)

Wisconsin –

- ***PROPOSED*** - USGS has proposed a project to evaluate and model hydrologic effects of sand mining for hydraulic fracturing around Chippewa County, Wisconsin and to establish a data-collection network (groundwater and surface water) that can track current and future effects (project initiated Spring 2012).

The cooperating agency is Chippewa County. A USGS report and factsheet are planned (factsheet to be published by the Wisconsin Geology and Natural History Survey). Data will be managed in and disseminated through the USGS National Water Information System. (NWIS) and be available to the public. (**Contact**: Charlie Peters, capeters@usgs.gov, (608) 821-3810)

Ohio –

- A study has been approved to assess the amount of water at 3 reservoir locations in the Muskingum River Watershed that could be sold to energy companies to develop gas wells without detrimentally affecting recreational pool levels. Potential cooperator is the Muskingum Watershed Conservancy District. The study will use historical reservoir level and outflow records and adjust for in-stream flow needs and the ability to pump any excess water. Various statistical analyses will be done for daily, monthly, seasonal, and annual available excesses. Excess-discharge mass curves (also called Rippl diagrams) will be prepared to aid in future assessments of storage requirements for various demands. (**Contact**: Greg Koltun, gfkoltun@usgs.gov, (614) 430-7708)

- Note: The Ohio Water Science Center is proposing work with the USGS Eastern Energy Resources Science Center to characterize produced fluids from drilling activities in the Utica Shale (**Contact**: Ralph Haefner, rhaefner@usgs.gov, (614) 430-7709)

North Carolina –

- USGS has initiated a project (2012) to conduct baseline groundwater quality sampling of public and private wells and compile well records in areas of potential shale gas exploration in the Triassic Basin of Lee and Chatham Counties, North Carolina. Cooperating agency and partners are the North Carolina Department of Environment, Natural Resources and Duke University Nicholas School of the Environment. The baseline data collected from both private and public water supply wells will be used by state and local agencies to identify background concentrations of major ions, metals, volatile organic compounds, methane gas, and stable isotopes in the aquifer prior to increased shale gas exploration in North Carolina. If shale gas exploration occurs, these data will be used to compare to post-drilling water-quality samples. Data will be managed in and disseminated through the USGS National Water Information System. (NWIS) and be available to the public. Any laboratory data (such as isotope calculations) that cannot be stored in NWIS will be made available via an interactive online GoogleMap showing geologic units, generalized well locations, depths, yields, and quality. The interactive GoogleMap will be published as a USGS Open File Report. (Press release; Study Area Map; More detail). (**Contact**: Melinda Chapman, mjchap@usgs.gov, (919) 571-4047)

Arkansas –

- USGS conducts multiple monitoring and interpretative efforts in north-central Arkansas associated with the Fayetteville Shale exploration (area underlain by the Fayetteville shale – the 4th largest recoverable gas play in the U.S.). Fourteen streamgages record streamflow in the counties experiencing the bulk of activities associated with the Fayetteville Shale exploration (10 of which were installed at the onset of natural gas development). Continuous and discrete water-quality and streamflow monitoring at 3 stream locations are used to establish a baseline for determining trends in water quality and quantity on the South Fork of the Little Red River and Cypress Creek. Water-quality sampling is conducted on Greers Ferry Lake and Brewer Lake—two lakes that serve as major drinking-water supplies for residents in central and north-central Arkansas. A computer watershed model of hydrologic processes within Cypress Creek Basin is being developed, and a groundwater quality monitoring program has been established to sample 150 domestic wells and springs in Van Buren and Faulkner Counties. Cooperators and (or) partners include Arkansas Water Resources Center (through the University of Arkansas Division of Agriculture); Duke

University; White County, Arkansas; Arkansas Natural Resources Commission; Arkansas Game and Fish Commission; Southwestern Energy; Conway Corporation; Shirley Community Service and Development Corporation; U.S. Forest Service, U.S. Army Corps of Engineers. (More information: http://ar.water.usgs.gov/Fayetteville_Shale/) (**Contact:** Jaysson Funkhouser, jefunkho@usgs.gov, (501) 766-3663)

Louisiana –

- USGS, in cooperation with the Louisiana Department of Natural Resources, will begin a new program in July 2012 to monitor groundwater quality in areas of active or planned hydraulic fracturing of shale formations in north, central, and southeastern Louisiana. Water samples will be collected annually from about 100 selected domestic wells in areas of current or future hydraulic fracturing activity. Samples will be analyzed at a USGS laboratory for selected physical properties, such as pH and specific conductance, major inorganic ions, and trace metals using an analytical schedule developed by the USGS National Water Quality Lab specifically for detecting the impacts of hydraulic fracturing. Analytical results will be compared to previous data to determine whether changes have occurred. All data will be entered and stored in the NWIS database and published on-line in a USGS Annual Data Report. (**Contact**: John Lovelace, jlovelac@usgs.gov, (225) 298-5481 x3210).

Texas –

- USGS is working in cooperation with the San Antonio River Authority to initiate and refine an appropriate suite of water-quality measurements for detecting and monitoring hydraulic fracturing-derived contaminants in surface water and sediments of the lower San Antonio River watershed, Texas. To accomplish this goal, this project includes (1) review of available data on hydraulic fracturing fluids and existing data from monitoring sites and previous studies within the watershed to develop a priority list of analytical schedules, and (2) collection and analysis of water and sediment samples for compounds known to be associated with hydraulic fracturing activities. The project will be completed in 2013. This study will provide much needed baseline data for a broad spectrum of contaminants that are associated with hydraulic fracturing in the lower San Antonio River watershed. (**Contact**: Steve Opsahl, sopsahl@usgs.gov, 210-691-9247)

Oklahoma –

- The USGS has been requested by the U.S. Environmental Protection Agency (USEPA) Office of Research and Development (ORD) to provide borehole geophysical data collection and analysis of a 400-foot well to be drilled in northwestern Oklahoma. The information will provide needed geophysical data for hydro-stratigraphic and hydraulic interpretations for future monitoring of groundwater in the vicinity of hydraulic fracturing operations of the Mississippian limestone in Alalfa County, Oklahoma. Geophysical measurements will include natural gamma, formation resistivity/conductivity, fluid resistivity and temperature, acoustic velocity/porosity, borehole imaging, neutron and density logging. Additional logs such as nuclear magnetic resonance (NMR) and induction conductivity will be collected after the well has been cased with PVC casing. Nuclear magnetic resonance data is useful to assess permeability and total porosity including percent volume of bound and free fluid in the formation. Induction conductivity will be used to locate the freshwater/saline water interface and assess movement of this interface before and after the hydro-fracturing operation. (**Contact**: Greg Stanton, gstanton@usgs.gov, 512-927-3558)

Colorado –

- As large-scale energy development continues in the Piceance Basin in northwestern Colorado, there is potential for changes in surface-and groundwater resources. USGS, in cooperation with over 25 entities, has created and maintains a public, web-accessible common data repository combining water-quality data

from various sources to establish a baseline assessment of the region's water resources. Collaborative partners supporting the project include the energy industry, local citizens, cities and counties, state agencies, the Bureau of Land Management, private consultants, the West Divide Water Conservancy District, and the Colorado River Water Conservation District. The data will be used to develop regional monitoring strategies needed to fill identified data gaps, and minimize redundancies in current and future water-resource monitoring. (**Contact**: Jim Kircher, jkircher@usgs.gov, (303) 236-6900)

- ***PROPOSED*** – USGS has proposed a groundwater-monitoring plan for the Piceance Cooperator Group in selected geologic units along the North Fork of the Gunnison River, Delta and Gunnison and Garfield Counties, Colorado, as well as a surface-water monitoring plan in the White, Colorado and Gunnison River Basins. Anticipated start date is in the Summer 2012 if the project moves forward. (**Contact**: Dave Brown, dsbrown@usgs.gov, (970) 245-5257).

- ***PROPOSED*** – USGS has proposed groundwater monitoring, including domestic wells and springs, in Routt County, which is facing substantial oil and natural gas development. The County is seeking effective and cost-efficient monitoring programs at multiple scales that can satisfy institutional and legal requirements associated with environmental compliance and land-use planning. An assessment of current (2012-2013) groundwater quality in Routt County would serve as a comparative data set with which to evaluate changes since the 1980s and serve as a baseline with which to evaluate effects of future land-use changes and development. (**Contact**: Dave Brown, dsbrown@usgs.gov, (970) 245-5257).

New Mexico –

- There is opportunity for work in the San Jan Basin but no proposed or current activities at this time (May 2012) (**Contact**: Linda Weiss, lsweiss@usgs.gov, (505) 830-7901)

Montana

- USGS will cooperatively fund three streamflow gaging stations with the Montana Department of Environmental Quality in areas of oil development. The locations and parameters of operation are still in discussion. (**Contact**: Wayne Berkas,wrberkas@usgs.gov, (406) 457-5903).

- ***PROPOSED*** - USGS has proposed a cooperative study to collect baseline water quality and water level data for freshwater aquifers near areas of proposed oil and gas development. The project area will encompass areas of potential oil and gas development by conventional and nonconventional methods in Montana, particularly in the northeastern and northern parts of the State. Cooperators and other agencies on the project include the Montana Department of Environmental Quality, Montana Bureau of Mines and Geology, Montana Department of Natural Resources and Conservation, Conservation Districts, and possibly some Tribes. The cooperative study will develop a recommended sampling strategy and protocols based on recent investigations of unconventional energy production. The sampling strategy and protocols will be communicated to local partners to ensure comparable data are collected across the State. A USGS data report is planned. Data will be managed in and disseminated through the USGS National Water Information System. (NWIS) and made available to the public. (**Contact**: Kyle Blasch,kblasch@usgs.gov, (406) 457-5901)

- ***PROPOSED*** - USGS and EPA have submitted a proposal to assist the Blackfeet Tribe with developing a groundwater quality and groundwater availability monitoring plan near areas of proposed oil and gas development. The USGS will also train the Blackfeet Tribe on groundwater quality sampling and data archival. (**Contact**: Kyle Blasch,kblasch@usgs.gov, (406) 457-5901)

Wyoming –

- USGS is undergoing a data-collection effort to characterize groundwater quality pumped from two deep USEPA monitoring wells located near Pavillion, Wyoming for a list of analytes that primarily replicates the list used by USEPA in 2010 (For more information on EPA's Pavillion groundwater investigation, visit: http://www.epa.gov/region8/superfund/wy/pavillion/index.html.) Additional constituents of interest are mainly those related to age dating to provide a preliminary understanding of groundwater flow. Cooperating agency is Wyoming Department of Environmental Quality. A USGS peer-reviewed report will be publically available through the Internet after all field and laboratory work and peer reviews are completed. The report will describe sampling efforts and quality control and assurance protocols, and present analytical and field results. Data will be managed in and disseminated through the USGS National Water Information System (NWIS).

  This activity is seen as a first-step, or phase 1 (completed in 2012), which will lead to a more comprehensive, phase 2, scientific investigation and interpretation of groundwater characteristics, fate and transport of contaminants, conceptual models, and collection of other important information. The phase 2 study will lead to a better understanding of contamination in the Pavilion area and the potential role of hydraulic fracturing on groundwater quality in the drinking-water aquifer. Both the State of Wyoming and the USEPA have expressed interest in furthering the scientific investigations at Pavillion and including the USGS in those efforts. (**Contact:** Dave Mott, dmott@usgs.gov, (307) 775-9162)

- ***PROPOSED*** - USGS currently is developing proposals with the Bureau of Land Management to develop a retrospective assessment of groundwater occurrence in the normally pressured Lance Formation, Sublette County, Wyoming and a field reconnaissance of existing water wells in the study area. (**Contact:** Dave Mott, dmott@usgs.gov, (307) 775-9162)

South Dakota –

- ***PROPOSED*** - In proposal stages is a collaborative study with the State Geological Survey of South Dakota and the North Dakota State Water Commission to evaluate demands from hydraulic fracturing (or "fracking") on water resources. Fracking is commonly used in petroleum production from the Bakken Formation of the central Williston Basin. Affected areas include eastern Montana, western North Dakota, and northwestern South Dakota. The study would include application of the Precipitation-Runoff Modeling System (PRMS, including a shallow groundwater module) on a pilot watershed central to this region. Present and projected water resources of the pilot region would be evaluated in light of water resources required for fracking and for associated development of supporting infrastructure (such as increased water demands from growing municipalities). Projections would be linked to ongoing USGS aquifer studies of the Fox Hill sandstone and glacial aquifers. (**Contact**: John Stamm, jstamm@usgs.gov, (605) 394-3222)

North Dakota –

- No active projects to date. However, discussions are ongoing with three Affiliated Tribes (Fort Berthold Reservation) and USEPA on potential water-quality studies related to energy development on the reservation, and with the North Dakota Department of Health on potential projects. (**Contact**: Joel Galloway, jgallowa@usgs.gov, (701) 250-7402)